

KINEMATICS - P1 & P2

(4 - 6 marks)

DISTANCE

(mm ¹⁰ → cm ¹⁰⁰ → m ¹⁰⁰⁰ → km)

Forward ÷

Backward x

SPEED

m/s or ms⁻¹

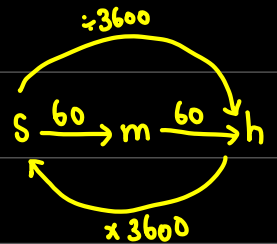
km/h or kmh⁻¹

$$\text{speed} = \frac{\text{Distance}}{\text{time}}$$

SPEED UNIT CONVERSION

1- Convert 72 km/h to m/s.

$$\frac{72 \text{ km}}{1 \text{ h}} \xrightarrow{\times 1000} \frac{72 \times 1000}{1 \times 3600} = 20 \text{ m/s}$$



2- Convert 40 m/s to km/h

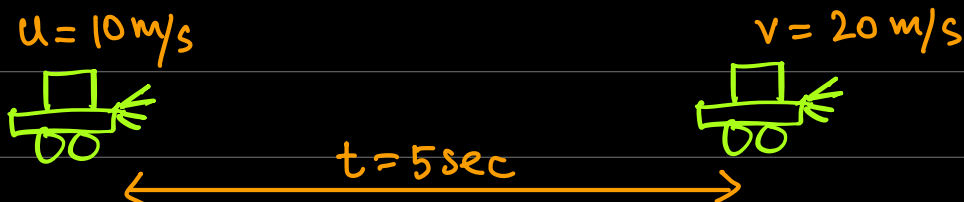
$$\frac{40 \text{ m}}{1 \text{ s}} \xrightarrow{\div 1000} \frac{40 \div 1000}{1 \div 3600} = \frac{40 \times 3600}{1 \times 1000} = 144 \text{ km/h}$$

ACCELERATION

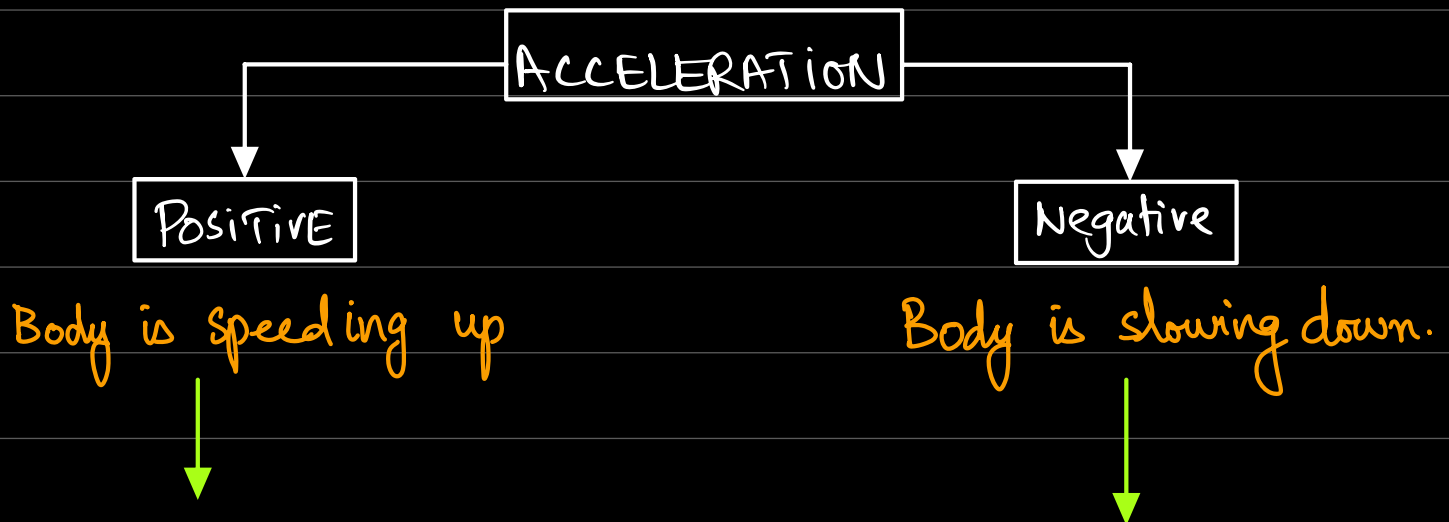
Distance	Speed	acc
m	m/s	m/s ²
m	ms ⁻¹	ms ⁻²

Rate of change of speed.

$$\text{acceleration} = \frac{\text{final speed}(v) - \text{initial speed}(u)}{\text{time}}$$

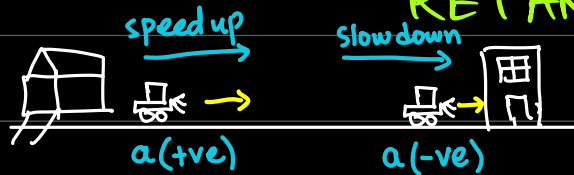


$$a = \frac{20-10}{5} = \frac{10}{5} = 2 \text{ m/s}^2$$



ACCELERATION

Acc +/- sign
cannot comment on
direction of motion
of a body.



DECELERATION

RETARDATION.

TILL NOW WE STUDIED TWO FORMULAS:

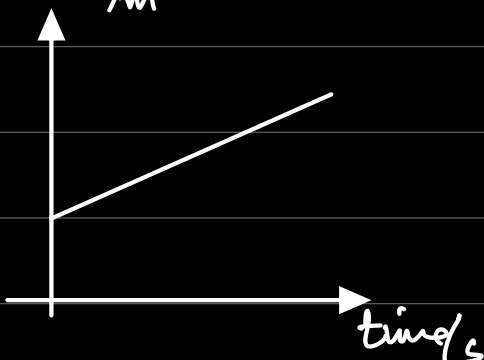
$$\text{speed} = \frac{\text{Distance}}{\text{time}}$$

$$\text{acc} = \frac{v - u}{t}$$

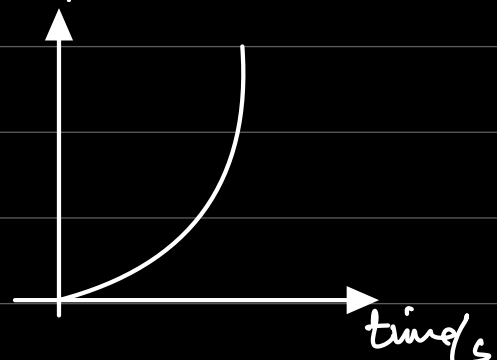
you cannot use these formulas on graphs.

GRAPHS

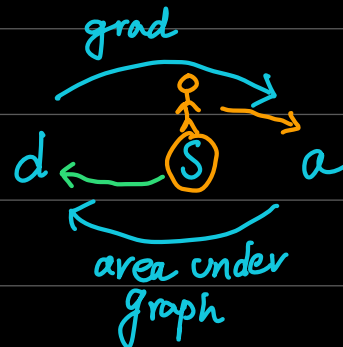
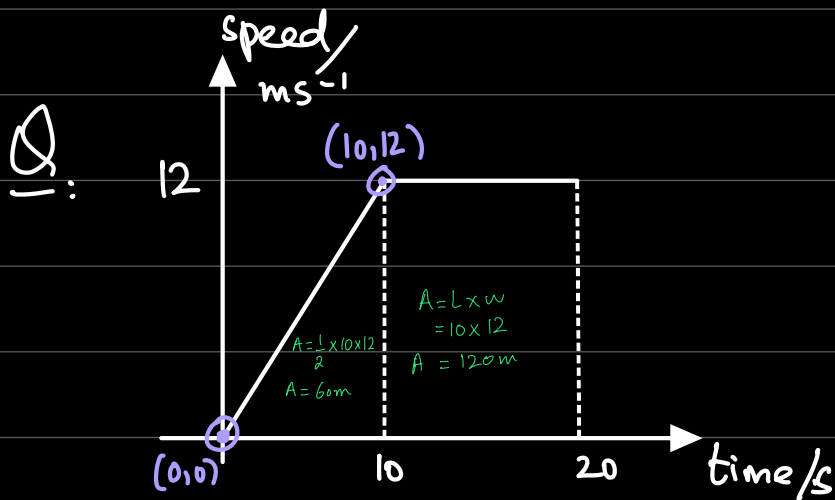
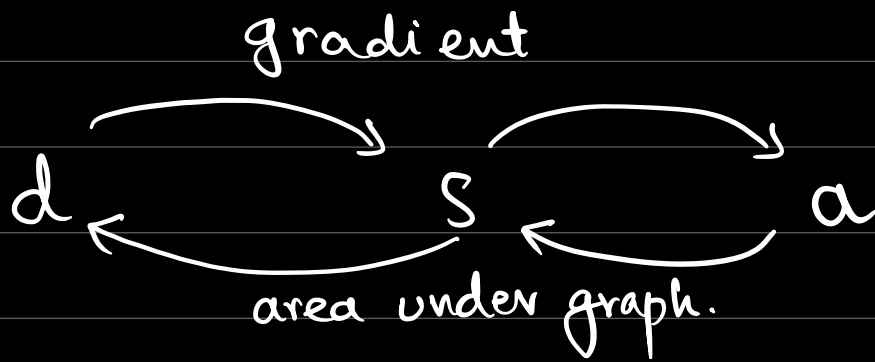
distance/m



speed /ms⁻¹



we have a beautiful shortcut for graphs.



(a) Find acceleration of object in first 10 sec

(0,0) (10,12)

$$\text{acc} = \text{grad} = \frac{12-0}{10-0} = \frac{12}{10}$$

$$\text{acc} = 1.2 \text{ m/s}^2$$

(b) Find distance travelled in 20 seconds.

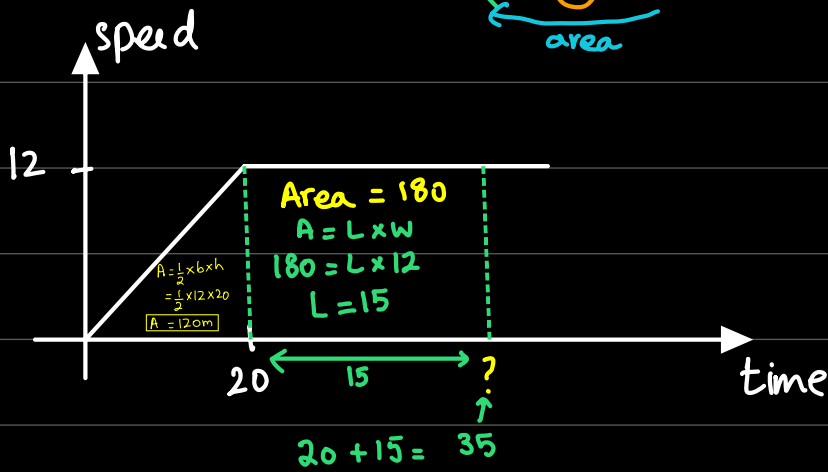
$$\text{Trapezium} = \frac{1}{2} \times h \times (a+b)$$

$$= \frac{1}{2} \times 12 \times (20+10)$$

$$= 6 \times 30$$

$$= 180 \text{ m}$$

CASE 1



Find the time when object has travelled 300 m.

Distance.
(area under graph)

$$\begin{array}{r} \text{Remaining} = 300 \\ - 120 \\ \hline 180 \end{array}$$

Final Ans = 35 seconds.

Thought process

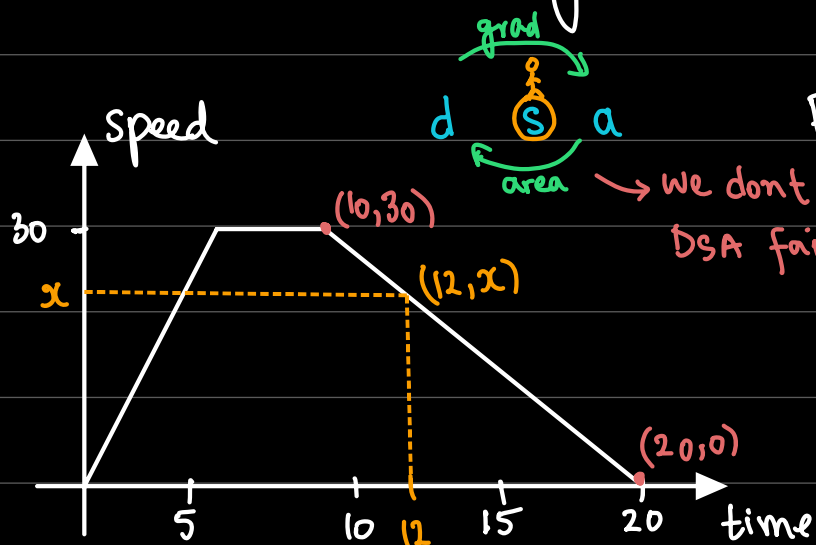
- 1) Find area of triangle
- 2) Subtract area of triangle from total area to get area of rectangle.
- 3) Use area of rectangle to find the missing length.

Case 2

dsa will not apply.

Find three points on a line

Find two gradients and put them equal.



Find speed when $t=12$.

We don't have to go anywhere.
DSA fails.

Find any two gradients and put them equal.

$(10, 30)$ $(12, x)$ $(20, 0)$

$$\frac{x-30}{12-10} = \frac{0-30}{20-10}$$

$$\frac{x-30}{2} = \frac{-30}{10}$$

$$\frac{x-30}{2} = -3$$

$$x-30 = -6$$

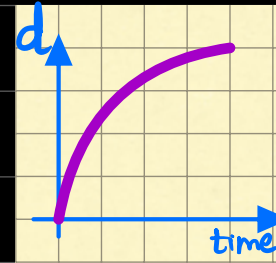
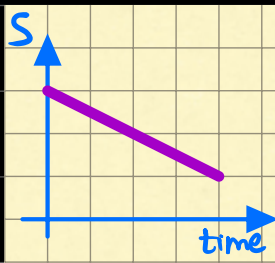
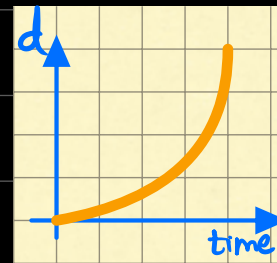
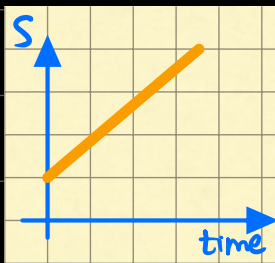
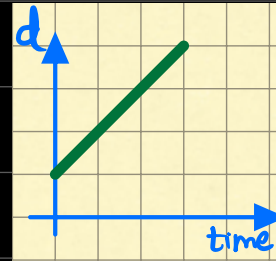
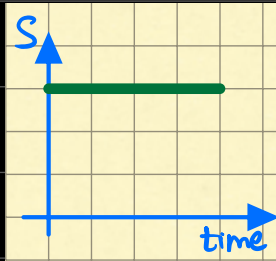
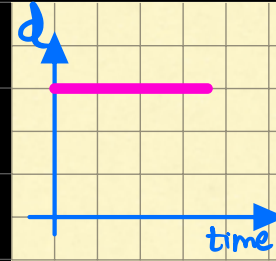
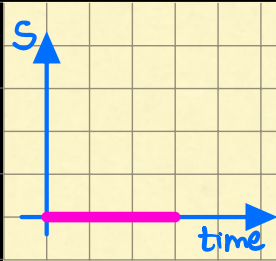
$$x = 30 - 6 = 24$$

$$s = \frac{d}{t}$$

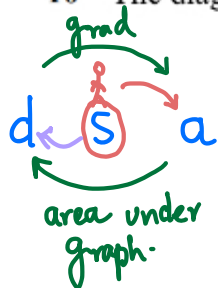
This formula is only correct
if speed is not changing.

Speed is constant.

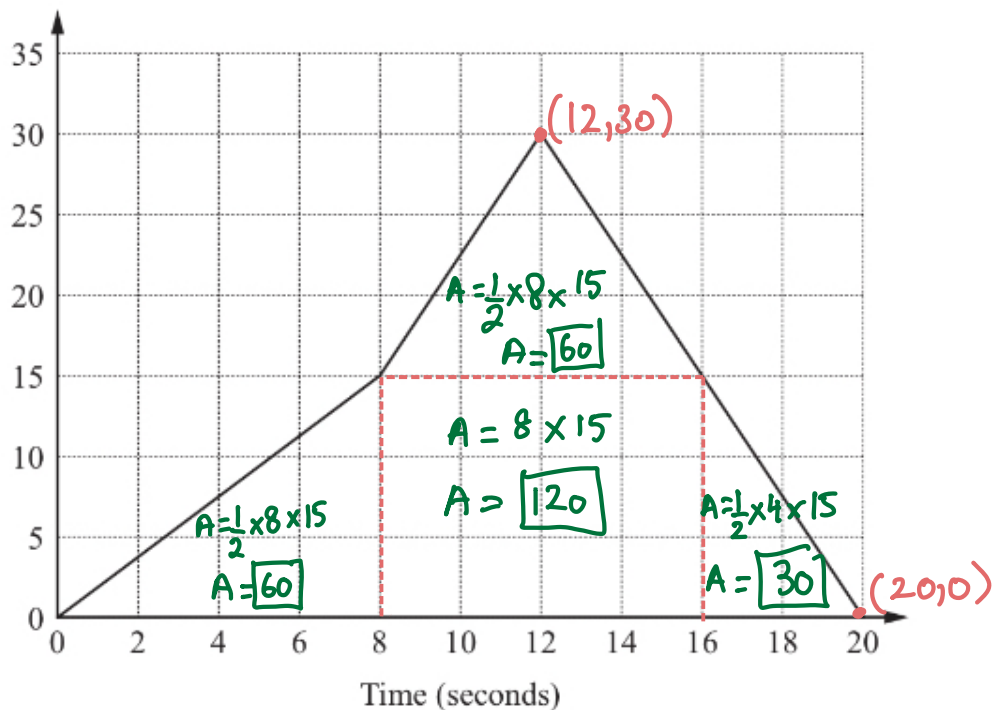
GRAPH CONVERSION



10 The diagram is the speed-time graph of the first 20 seconds of a motorcyclist's journey.



Speed
(metres per
second)



- (a) Calculate the motorcyclist's retardation during the final 8 seconds.
(b) Calculate the distance travelled in the 20 seconds.

$$\begin{pmatrix} (12, 30) & (20, 0) \\ x_1 & y_1 & x_2 & y_2 \end{pmatrix}$$

$$\text{acc} = \text{grad} = \frac{0 - 30}{20 - 12} = -\frac{30}{8} = -\frac{15}{4}$$

$$\text{acceleration} = -\frac{15}{4}$$

$$\text{retardation} = \frac{15}{4}$$

Total Distance travelled

$$60 + 60 + 120 + 30 = 270 \text{ m}$$

Answer (a) m/s² [1]

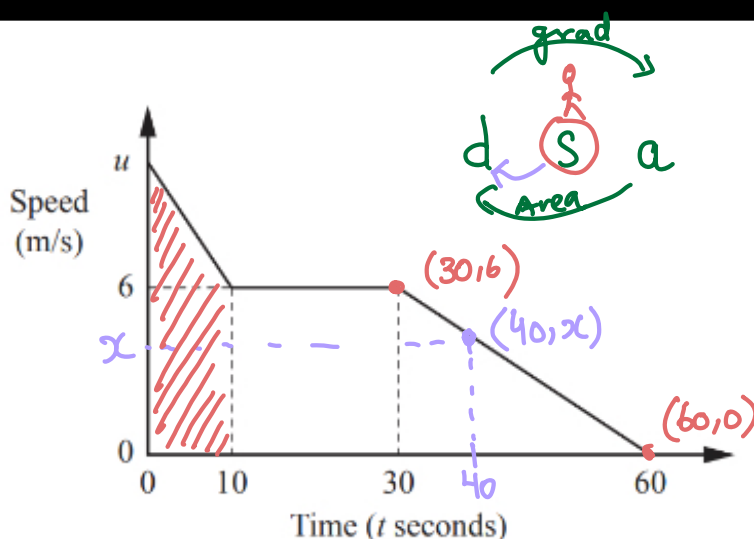
(b) m [2]

- 27 The diagram is the speed-time graph of part of a train's journey.

The train slows down uniformly from a speed of u m/s to a speed of 6 m/s in 10 seconds.

During the next 20 seconds it travels at a constant speed of 6 m/s.

It then slows down uniformly to a stop after a further 30 seconds.



- (a) Calculate the retardation from $t = 30$ to $t = 60$.

$$\text{gradient} = \text{acc} = \frac{0-6}{60-30} = \frac{-6}{30} = -\frac{1}{5}$$

$$\text{retardation} = \frac{1}{5} \text{ m/s}^2 [1]$$

- (b) Calculate the speed of the train when $t = 40$.

$$\begin{array}{l} (30, 6) \quad (60, 0) \quad (40, x) \\ \downarrow \quad \quad \downarrow \\ -\frac{1}{5} = \frac{x-0}{40-60} \end{array} \quad \begin{array}{l} 5x = 20 \\ x = 4 \end{array}$$

$$-\frac{1}{5} = \frac{x}{-20}$$

$$\text{Answer } 4 \text{ m/s [1]}$$

- (c) The distance travelled by the train from $t = 0$ to $t = 10$ is 85 m.

Find u .

$$A = \frac{1}{2} \times h \times (a+b)$$

$$85 = \frac{1}{2} \times 10 (6+u)$$

$$170 = 10 (6+u)$$

$$17 = 6+u$$

$$u = 11$$

$$\text{Answer } u = \dots\dots\dots [2]$$

